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THE NEW SCIENCE OF GEOGRAPHY*

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Geography, although perhaps the oldest of the sciences, has changed so completely in recent years that its true nature is not commonly understood, especially in America. Like every other science, it includes three phases or stages, each of which is characterized by a special mental process. The first, or empirical stage, is concerned merely with the gathering of a great body of unrelated facts. In the second, or systematic stage, these facts are classified and arranged in definite categories; while the third, or explanatory stage, is devoted to the explanation of the facts and to the determination of the laws which govern them. To these may be added the predictive stage, in which the laws of the explanatory stage are used to predict future occurrence; but with this we are not now concerned.

No one of the later stages can exist without all its predecessors, and in a mature science the processes of gathering, systematizing, and explaining go on side by side. For example, students of botany fall into three categories: plant-gatherers, whose chief joy is to find a new fern or alga; systematists, who laboriously describe and classify what others find; and true botanists, who use the work of their co-laborers as the basis for the discovery of new laws or of new applications of old laws.

The degree of interest possessed by these various stages varies greatly in different sciences. In most branches of knowledge, bare facts and their systematic classification are of no particular interest except to the specialist. The world at large is concerned chiefly with general laws or practical applications. The ordinary individual cares nothing about the atomic weight of polonium, for instance, or about knowing that it is seventh in the series of elements produced from radium. If he is told that its "half period of transformation" is 140 days, and that the range of its rays in the air is 3.86 centimeters, he does not understand what is meant, and promptly forgets the whole matter. Toward the laws, however, which govern the action of polonium, his attitude is quite different. The first great law is that the transmutation of metals can and does take place—not as the alchemists supposed, but in a far more significant fashion. In the light of this law, the statement that polonium is the seventh in the series of radium derivatives takes on a new meaning. For some absolutely unknown cause, radium and other radioactive substances are not permanent, in spite of the fact that they are genuine chemical elements. In periods varying from billions of years to the five-hundredth part of a second, they are transmuted into other substances, which likewise are genuine chemical elements. The more we know of this law, as distinguished from the empirical facts of observation, the more our interest and wonder are aroused. The activities which it governs cannot be initiated, hastened, hindered, stopped, or otherwise altered by any known means. The activity of hot bodies, on the other hand, can be changed by cooling; magnetic masses can be demagnetized; moving bodies can be stopped or deflected from their courses; and living beings can be killed. Gravity alone is as unchangeable as radioactivity; do what we will, we cannot cause a particle of matter to lose or change its power of attracting other particles; nor can we alter the process by which radioactive substances steadily transmute themselves and give off energy in a long and complex process of gradual decay. This it is—this immutable law—which forms the climax of interest in any study of radioactivity.

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In the science of geography, the laws are no less interesting than in radioactivity or any other branch of science, but this is rarely recognized. Attention is commonly concentrated on mere facts instead of on the laws which govern them. One reason for this is that the laws, dealing as they do with life as well as matter, are in the highest degree complex and difficult to frame. Another reason is that the facts themselves are of great interest, even apart from the laws. Take such an unimportant item as the ichthyophagi. Two thousand years ago, the Greeks heard with wonder of tribes whose sole diet was fish. Nearchus, who accompanied Alexander to India, tells of ichthyophagi along the coast of Makran in southern Persia, and modern travelers confirm his accounts. They add that the country is so barren that, in years of drought, even the abstemious donkeys cannot find sufficient grass or weeds to support life, and would die, did not their masters feed them upon dried fish. Pliny locates the ichthyophagi on the islands of the Persian Gulf; Pausanias mentions others on the west coast of Arabia where Burton found them in modern times; and other travelers report them elsewhere. Ancient scientists and modern authors of books of travel are not the only persons interested in fish-eating tribes. In central Asia I told my caravan men one day that I proposed to visit the Lopliks who lived several hundred miles to the east on the shores of the shallow and almost dry lake of Lop-Nor. After a few hours, one of the men came back from the market-place, whither he had been to make inquiries, and proceeded to ask questions. "Is it true that those Lopliks whom we are going to visit eat nothing but fish? What beasts they must be. And is it true that they are so skilful in eating fish that they can put the meat in at one side of their mouths and spit the bones out at the other side at the same time?"

Geographical facts like those pertaining to the ichthyophagi are almost innumerable. Strangely enough, their interesting nature, large number, and wide distribution are among the chief causes why geography still labors under the imputation of being a purely empirical or descriptive science. Because the facts in themselves are entertaining, there has been a failure to realize the necessity of coördinating them and finding out their laws. Geographers themselves have fostered this idea. The majority of them have failed to apprehend that the mere collection of facts is not science. Moreover, because of the vast number of highly interesting geographical phenomena scattered all over the world, every traveler has felt impelled to gather his own little sheaf. Having published his observations, he has considered himself a geographer, although with no more claim to the title than has the gatherer of a bunch of wild flowers to be called a botanist. Genuine geographers have rebelled against this invasion of their province by men of no adequate training. Yet instead of directing their own energies to the patient sifting of facts, in order to discover laws, they have zealously devoted themselves to mapping new portions of the earth's surface. Their work has been done scientifically and is of great value, but it belongs to the first, or empirical, stage of the science. In their zeal for this work, they have often forgotten the other phases of the subject. Thus, although thousands of men, both travelers and map-makers, have been called geographers, only a handful have given their lives to the work of systematic classification, and still fewer to the final explanatory stage of the science. This, more than anything else, explains the common but fallacious idea that geography is purely descriptive and lacks the qualities of real science.

In order to arrive at a true understanding of the present and future status of geography, let us examine the nature of the subject and its adaptation to the purposes of higher education. The courses in the German universities, where the subject is best taught, deal with a wide range of subjects, but in spite of their great diversity, all center around one basic idea, the keynote of geography. Just as the physiological chemist, the botanical chemist, the metallurgist, the general chemist, the inventor of dyes, and a score of others are all chemists engaged in answering the questions: "What is it made of?" and "How is it put together?", so the geographers, as Professor J. L. Myres, of Oxford, has well put it, are all answering the questions: "Where is it?" and "Why is it there rather than elsewhere?" Geography is primarily the science of the distribution of phenomena on the earth's surface; maps are its foundation, just as systematic floras are the foundations of botany. The geographer deals with everything whose distribution can be shown upon a map, whether it be incised meanders, chinook winds, yellow skins, or cowardice. This does not mean that geography is a blanket science composed of interesting bits from all the neighboring sciences, and therefore no science at all, as is sometimes thought. The chemist may legitimately study meanders in the sense of analyzing water, soil, and rock; he may investigate the chemical differences between warm, dry chinook winds and other winds; he may ascertain the nature of the pigments which make one skin yellow and another brown; and he may tell us that the mental state known as fear or cowardice is accompanied by the formation of certain toxic substances which can be detected in the blood or breath, and which hinder the bodily functions. Yet no one thinks of denying that chemistry is a distinct and full-fledged science. The chemist is obliged to study everything, but he does so for the definite purpose of determining the nature and amount of the various chemical elements, their mode of union, and their changes. In the same way the geographer studies everything, but he does so in order to determine where things are located, and why they happen to be there rather than in some other part of the world.

Take such a matter as the trade of China. The economist studies the laws of trade and applies those laws to China. He accepts the fact that China's trade per capita is not one one-hundredth as large as that of Belgium, but that does not concern him greatly, for the laws of production and exchange are the same in both countries. It is beyond his province to attempt a complete analysis of exactly why conditions in China and Belgium are different. He must leave that question to geography, the only science whose function it is to answer it. The economist may and must use the geographer's results or methods, just as the astronomer must call on the physicist for help, or the historian on the philologist. It is no part of the economist's task, however, to investigate the relation of topography to geological structure; he is not concerned with seasons of rainfall and crops as the result of planetary and terrestrial pressure-systems; he does not investigate lines of communication as determined by space relations, nor the distribution of population and the consequent variation of modes of life from place to place. He simply cannot do it, partly for lack of training, and partly for lack of time. To find out why a certain phenomenon is located in a special corner of the earth is as distinct and complex a problem as to discover the mathematical formulas for the strains and stresses in a bridge.

Thus far we have been considering the present position and nature of geography, and the reasons why its function has been misunderstood. Let us now consider its educational value. The essential criteria in determining the educational value of a subject may be stated in many ways. For our present purpose we may state them as follows: (1) the importance of the subject in everyday life, (2) historic importance, (3) cultural value, (4) definiteness of the field of study, (5) organization of material, and (6) disciplinary value.

The importance of a subject in everyday life and its consequent importance in education are well illustrated by chemistry. No thoroughly equipped man can afford to be ignorant of the principles of this subject, because it fills so large a place in the world's activities. The second criterion, historic importance, commonly has as much weight as present importance in determining what studies shall be employed in the training of our youth. It is this, in large measure, which keeps Greek and Latin in our curricula. The third criterion, cultural value, is in itself sufficient to justify attention to a subject. We devote a great amount of energy to the study of English literature, largely because a man thereby lays up a store of that which lends interest to his own inner life, grace and point to his speech, and discernment to his taste. The very fact that literature is so important culturally makes amends for its failure to satisfy the next criterion, definiteness of the field of study. Literature is avowedly a somewhat indefinite field, differing in that respect from history. While the student of literature does not pretend to be seeking an answer to any definite question, the historian has always present in his mind the query, "What happened, where, and why?" and hence he knows exactly how to go to work. Definiteness of field is closely connected with the next important criterion, organization of material. Mathematics is preeminent in this respect. Not only are its laws framed with the most absolute precision, but its method of presentation to students has been developed to the highest degree. The last criterion, disciplinary value, is possibly the most important of all. It depends largely upon definiteness of field and organization of material, and also upon the degree of interest of the subject-matter itself. Physics is notable in this respect, because it combines the most abstruse reasoning with highly interesting and stimulating experimentation.

No one subject fully satisfies the requirements of all these criteria, but that is not to be expected. All the subjects which now hold an important place in the ordinary college curriculum, satisfy the majority of the criteria, and geography seems to hold its own in this respect. Taking geography in the modern sense as the science which explains why things are where they are, there is no need of explaining its importance either in the life of to-day or in that of the past. No question, for example, is more worthy of profound study than that of why the island of Japan is inhabited by people so markedly different from those of the neighboring mainland. As a matter of culture, also, the consideration of such problems is of the highest value. Without further discussion, there fore, we may fairly assert that in regard to the first three criteria —present importance, historic importance, and cultural value— geography holds a high position. The fourth criterion may also be dismissed, for we have already shown the definite nature of the field of geography as the science dealing with the distribution of phenomena on the earth's surface and with the reasons for that distribution.

The question of the organization of material is the criterion which geography has at present most difficulty in satisfying. It cannot be gainsaid that, except in the elementary phases of the subject, good text-books are rare. Geographers themselves are still discussing the question as to how the subject should be presented to students. Several effective methods are now in use, and university teachers are already in accord upon the fundamental principles of presentation. It is nevertheless true that advanced geography cannot be successfully taught by a teacher who relies on text-books rather than on his own initiative. In this respect, however, the science is scarcely worse off than the rest of the newer sciences, such as experimental psychology, anthropology, and the other sciences dealing with man as a biological product. In all of these subjects advances are so rapid that a good teacher cannot stick to the text-books, but must lay out his work along his own lines.

We come now to our last and most important criterion, disciplinary value. Does the study of geography compel the student to pursue a definite chain of reasoning, link after link, and does it thus train him to think? The descriptive phases of the subject, upon which the lay mind places such undue stress, have neither more nor less value than the learning of dates and events in history, or of the names, properties, and numerical values of the elements in chemistry. The explanatory phase, however, demands as close and careful reasoning and as great mental activity as are required by any of the other sciences.

An example will make this clear. As everyone knows, the people of India are shackled hand and foot by an inexorable system of caste. So strong is it that Moslems and even Christians cannot escape from its exactions. I have seen poverty-stricken Moslems throw away a large supply of good food because it had been prepared for the table of a Christian. Their own religion did not prevent their touching it, but they were filled with the Hindu prejudices of their ancestors and their neighbors. In a rural district of the Deccan, while riding in an oxcart to visit the Buddhist cave-temples of Ajanta, I have paid for a newcomer's ignorance of the absolute dominance of caste by going hungry for a day. Even water was unprocurable except by having the driver go to a wayside well, fill the brass bowl which he carried in his girdle, and pour the water into the foreigner's hands without letting him touch it. The first time that we wanted a drink I inadvertently put out my hand to take the bowl, the Hindu, fearing pollution of his drinking vessel, jumped back as if he had seen a tiger.

In Arabia, on the contrary, quite the opposite condition prevails. Nowhere in the world, probably, is there a greater degree of fraternity and democracy than among the Arabs, especially the nomads. So strong is the spirit of democracy that it has spread its influence more or less into all Mohammedan lands, including even parts of India. The richest and the poorest of the Arabs put their hands to the same dish; and the stranger, be he black man or white, is invited to share the best that the Arab can procure. The contrast between the spirit of caste among the Hindus and that of democracy among the Arabs may be treated from the religious, the historical, the sociological, and perhaps other points of view, but that need not here concern us. From the point of view of the geographer, the important fact is that this contrast occurs in two similar peninsulas lying side by side in almost the same latitude on the southern side of the same continent. Is there any respect, he asks, in which physical environment has fostered the development of caste in India and of democracy in Arabia? Could the reverse have happened?

With these questions in mind the geographer investigates the physical phenomena of the two countries. He finds first that the geological processes of continental uplift, faulting, folding, vulcanism, erosion, and recent oscillations of the relative level of land and sea, have produced a rather marked similarity between the two peninsulas. If the mountainous district of Oman, on the east of Arabia, be omitted, the resemblance is truly striking. An arc of mountains lies on the north; then come vast, fertile river plains; farther south, the center of the neck of each peninsula is occupied by a mass of ancient mountains maturely dissected; on the west coast of the peninsulas proper, a steep escarpment prevents easy access to the sea; while at its top, great lava fields spread eastward over an area of thousands of square miles. From the lava fields a long slope stretches across to the low east coast, where recent uplift has produced a coastal plain; and finally, in the far south of both India and Arabia, high mountains rise to face the southern ocean. If topography alone controlled the fortunes of a country, India and Arabia should fare almost alike, with a slight advantage on the side of Arabia.

From topography we turn to space relations, and find that in this respect Arabia is decidedly the more favored. Lying, as it does, between India and Europe, with Africa on the one flank and Turkey and Persia on the other, it ought to be in the very center of the world's activity. If other conditions were favorable, it would be touched and vivified by influences from four highly diverse types of civilization, and could scarcely fail to respond. Its relation to the sea would be another factor tending in the same direction. India, with her precipitous west coast and harborless east coast swept with drifting sand, faces seas so wide and islandless that her people have never been tempted abroad to any great extent. Arabia, on the contrary, although not blessed with many good harbors, has long stretches of coast which are good for habitation, so far as topography alone is concerned, and which face narrow seas or gulfs favorable to primitive maritime enterprise. Even under the present hard conditions of life, maritime enterprise has been fostered in Arabia more than in India, and to this, in part, is due the fact, that Mohammedanism, not Hinduism, has spread to the East Indies.

The relative advantages of Arabia over India in topography, space relations, and coasts are completely nullified by its climate. Everyone knows that both countries are characterized by great climatic extremes, which cause some sections to be absolute deserts, while others are abundantly watered and highly fruitful. Everyone knows also that the chief difference between the two is that in India the desert areas are relatively small, while in Arabia the watered areas are even smaller. Few, however, understand why this is so. An adequate explanation, such as is demanded by modern geography, borrows from the physicist the laws of gravitation, rotation, expansion of gases, latent heat, condensation, and other matters. From these it works out first the planetary zones of pressure, and the terrestrial modifications of these zones by the tilting of the earth's axis and by the distribution of land and sea. Then, knowing where and why areas of high and low pressure occur at certain seasons, the geographer is in a position to understand what winds will blow in Arabia as compared with India, and what amount of condensation of vapor will take place under given conditions of topography. The line of reasoning is too long and complex to be given here, and we must hasten on to apply our conclusions to the caste system.

When the topography, climate, and other physical factors are understood, the geographer investigates their effect upon human occupations and modes of life, and upon the distribution of industries. He finds that in the major part of Arabia nomadic pastoralism is the only possible form of life. Even in the oases no great variety of occupations, or of modes of cultivation, is possible because of the extreme limitation of resources. The villager, whether in the north or the far south, raises a little wheat or millet and waters a few palm trees, set either in deep pits to be as near as possible to the level of ground water, or else located beside the brackish, lukewarm stream from some small spring in the midst of a waste of verdureless desert. Often the villagers own the trees in common with the nomads. The villagers do the work of irrigation, getting water from wells, perhaps, by means of a long rope, a leather bucket, a pulley, and a patient camel striding slowly back and forth. The nomads protect the trees from raids by enemies, and are responsible for the safety of the village. For this seemingly slight, but really large, service they receive half the crop of dates. For a thousand miles and more, one oasis scarcely differs from another, and monotonous uniformity is the rule. Moreover, the nomads are compelled to move constantly from place to place in search of water or pasture, and often they go hundreds of miles each year. Thus they come into constant touch, not only with one another, but with the oasis dwellers near whom they are forced to camp in order to get water in times of especial drought. This, too, tends to promote uniformity, for local customs have little opportunity to grow up. Again, no nomad can carry any very large or sumptuous tent, or great abundance of furniture, on his camels; and the differences in style of living between rich and poor are thus limited.

Still another factor tending toward uniformity results from the peculiar moral standards of the desert. In years of scanty rainfall, no grass sprouts up in the early spring at the time when the young are born. The hungry mother camels have no milk whereon to nourish their colts, and the poor little creatures soon die. Nor is there milk for the Arabs themselves, and no hard, sour curds can be laid by for winter use. The date crop and the grain in the oases are also scanty; and gaunt famine stalks among the black tents of the desert. Under such circumstances the only resource is plunder. The man who is hungry, and whose wife and children are starving, has little thought of right or wrong. If he can take the property of someone outside the range of his own tribe and friends, he feels that he is doing right. To think otherwise would mean starvation. Thus, through thousands of years, the hard conditions of the desert have steadily weeded out all who withheld their hands from violence. Raids and plundering expeditions are a matter of course among the Arabs. There is nothing to put a stop to them, for there is nothing to favor the growth of a moral sentiment against them. Thus it comes to pass that rich and poor alike, but especially the rich, who have the most to lose, are in constant peril of being reduced to beggary by a raid of their neighbors. So common is this that a man's social position has little connection with the number of his camels. If an Arab is reduced to dire poverty by a raid, his friends often contribute camels enough to enable him to support his family, and this is not considered charity, but merely justice. All the Arabs are subject to the same dire pinch of hunger and to the same danger of utter impoverishment; and this, as much as anything, helps to keep them democratic.

In India the conditions are almost the opposite of those in Arabia. The favorable rainfall of the major part of the country promotes a sedentary life; and an abundance of forests and the ravages of wild beasts combine with a rough topography, in many portions of the peninsula, to prevent much intercourse. To this is added the effect of a uniformly warm climate with few and gentle changes, a condition which deadens initiative and activity and gives rise to mental and physical inertia. Moreover, the extreme variation of natural conditions in regions not far remote from one another, compels the people to raise their crops, build their houses, make their clothes, and carry on a hundred other occupations in wholly diverse ways. Thus the geographic conditions of India tend as strongly toward diversity as do those of Arabia toward uniformity.

The geographer cannot leave the matter at this point. He must find out why India is inhabited by a most heterogeneous mixture of races, and Arabia by practically pure Semites. Most of the people of India, so far as we know, came from the north or northwest, that is, from the dry districts of central Asia, including Persia, Afghanistan, Russian and Chinese Turkestan, Tibet, and Mongolia. During exceptionally dry seasons, as travelers have seen again and again, the nomad of these regions are forced to migrate long distances in search of pasturage, and often come into warlike conflict with their neighbors. In the past, certain periods lasting for centuries appear to have been times of prolonged favorable rainfall, and these have been followed by centuries of increased aridity. During each dry period, the people of central Asia have been forced outward and have moved into China, India, Asia Minor, or any other region where life was possible. A full understanding of this matter involves a review of a vast amount of topographical, meteorological, archæological, and historical data, and a careful weighing of evidence. Adverse climatic periods, together with overpopulation due to other causes, have induced migration after migration into India. Therefore, the people of different parts of the country vary in race, language, customs, ideals, and religion. In many places, also, the population has become stratified as it were, conqueror after conqueror imposing his race as the exclusive upper stratum of society. When India herself has suffered from overpopulation she has had no relief. Hemmed in by huge mountains, vast deserts, hungry nomads, and wide seas, her people have never been able to move out to new lands. Those who could not get a living have died of starvation, but nothing has happened to obliterate the human diversity due to her physical diversity and her frequent invasions.

In Arabia, on the contrary, because the country is a desert, the great movements have all been outward, never inward. When favorable times allowed of increase of population it has come about almost wholly by growth from within, not by migration from without. Thus Arabia has preserved unity of race, speech, and customs, while India has grown more and more diverse. The one has been prepared by nature for a religion of which democracy is the keynote, the other for a religion bound in the fetters of caste. It could scarcely have been otherwise.

Here the geographer leaves the matter. It is not his function to study the intricate ramifications of Hindu caste or of Moslem democracy. That must be left to students of comparative religion or anthropology. Geography stands, as it were, between the science of geology, which deals with the past and with the interior of the earth, and the great group of sciences, such as biology, ethnology, economics, and history, which deal with life as it now exists. The field of geography as the science of the distribution of phenomena upon the earth's surface is distinct and well defined; its laws, although intricate and as yet only beginning to be known, are precise and clear; and its sustained and intricate modes of reasoning are in the highest degree disciplinary.